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ERP Inter-enterprises for the Operational Dimension of the Urbanized Bid Process Information System

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Abstract

Bid process translates the techno-economic expertise, which partners build in a cooperative way. It is a key business process which evaluates the results of different trade tasks: hence, it influences the company's survival and strategic orientations. Therefore, the Information System that supports this process must be characterized by integrity, flexibility and interoperability. Nevertheless, the urbanization approach, on which we rely to implement this system, has to deal with "three fit" problems. To overcome these problems, we suggest addressing these exigencies following an operational dimension which remains responsive to other dimensions: the organizational and decision-making ones. However, the cooperative dimension covers the remaining dimensions. In fact, it ensures the consistency and the interaction between the different dimensions. We are not only interested in identifying the tools and applications needed to achieve a bid process, but we aim, also, at solving problems related to interactions intra, or even inter-applicative. Our major concern is to realize an ERP (Enterprise Resources Planning) that targets a bid process operational dimension while promoting a cooperative construction of the offer's techno-economic proposal.

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1. Main text

The owner calls for a bid to benefit from a product or service; after some period, he receives many proposals from different participating companies which submit their responses to this call for tenders (bid process). A bid process embodies a techno-economic proposal (a technical expertise backed by a financial offer). Such a contribution translates preliminary, the recommendations proposed by each contributor, either to reconstruct the desired product, or to organize the required service. Therefore, it is an elementary study that takes place before negotiating the contract with the owner, i.e. before launching the project. The bidder (company that pilots the bid process) might

appeal to some partners, especially during the construction of the technical proposal. In the meantime, we can have new calls for bid following the first one and so on. Obviously, each participant seeks to cover and meet mainly his financial benefits because it is recognized as the most powerful and incorporating dimension. It interrelates with and touches the other dimensions like the: technical, political, social, hygienic, environmental, legal, ethical, ones etc. For this reason, in each evolutionary step of the bid process, collaborators can renounce their participation by the time of the final submission when they recognize that such a deal does not cover their objectives. Indeed, most of the participants who decide to pass their last proposal, make a thorough evaluation exercise that tests the feasibility and effectiveness of the offer, through the technical, economic, temporal, and risk indicators. Thus, the bid process is a key business process of the company insofar as it directly affects its future and locates its expertise as well as its competitiveness in relation to its competitor [1]. In fact, the owner focuses on the best offer, which meets its requirements and which covers the eminent interests. Once gained the offer, the bidder and, eventually, his collaborators create the bid process team. The latter makes part of the industrial consortium which targets to realize the project in practice. Certainly, it is the company's agility and competence that allows acquiring the customer's confidence and interest, and as a consequence wins the offer. It is to remember that doing business means taking risks, something that can influence the company's growth and survival. So, the strategic management of business is a major and current concern to an innovative enterprise. The latter promotes to restructure its Information System (I.S) around its trades and business processes. The I.S is the executing support of the processes of business. However, it directly influences the internal and external environmental requirements of the company. Internally, the *consistency* of an I.S depends utterly on its degree of integrity, flexibility and its internal interoperability. While externally, I.S *agility* always depends on its flexible capacities and external interoperability [11]. Nevertheless, the reality shows *agility* and *consistency* problems on both inter as well as intra levels. We prove this premise when we apply the urbanization approach [8]. It consists of three transposition problems dubbed as "*three fit*": (i) "*vertical fit*" (lack of integrity and lack of extensibility); (ii) "*horizontal fit*" (lack of flexibility and lack of internal interoperability); (iii) "*transversal fit*" (lack of openness and lack of external interoperability). Our main objective is to suggest I.S which supports the bid process. Actually, this system must be: *integrated, flexible* and *interoperable*. We treat these aspects following four dimensions: (i) the *operational dimension* which aim to specify the bid operation process designated for a specific project; (ii) the *organizational dimension* which targets to specify the set of skills and knowledge that the company had acquired due to previous bids in order to eventually reutilize this patrimony in future bid projects; (iii) the *decision-making dimension* whose goal is to optimize decisions on the market's supplies; and finally, (iv) the *cooperative dimension* which seeks to plan the inter-enterprises cooperation that take place during the construction of the techno-economic proposal of the offer. We are interested, not only to specify the tools and applications necessary to cover these different dimensions, but also, to solve problems related to interactions intra, or even inter-applicative. Specifically, we are focused on the *operational dimension*.

This article is organized as follows. First, we identify the required characteristics I.S supporting a bid process. Also, we focus on the hindrances encountered while implementing I.S: problems of "*three fit*". Second, we suggest an urbanized I.S, to overcome these limitations. Third, we specify the operational dimension of our bid process I.S. We finish this work by a conclusion that opens the horizons to our future research projects.

2. Required Characteristics and Problems Implantation of the Bid Process Information System

2.1. Required Characteristics of the Bid Process Information System

The bid process involves a level of strategic intervention, since it is located upstream, in the conceptual stages of the lifecycle of a project or product. It is considered of innovative, as it allows predicting and planning product design activity: it optimizes the costs of its construction with respect to its production deadlines, and it minimizes the risks of any future exploitation in a way that ensures a good quality services. Moreover, the bid process is of preventive nature, it embodies a commitment and consensus, trying to cover, not only the owner interests, but also those of the main contractor or supervisor. Indeed, it is a predetermined protocol between two parties; a protocol which seeks to define workable solutions, while respecting the constraints and objectives fixed in the specifications. In addition, it is non-deterministic, as it does not admit standard solutions: each bid process takes place in a definite environment, occurs in a specific context and envisages precise solutions. Nevertheless, the bid development

requires an "in-time" response especially when the competitive environment in which the participating company is involved is taken into consideration. Furthermore, the bid process requires a cooperative structure, since it is the basis of intercompany collaborations during the technical proposal construction. However, the bid process has a decisive role, because it has a direct impact on the strategic orientation of the participating enterprise. Eventually, it is of recurring nature, since it can generate new calls for tenders, from the initial call. The I.S which supports a bid process must be:

Integrated: the company regularly participates in bids, during which, it reutilize its technical skills and business, to subsequently take optimal business decisions. It is in this way that its I.S must be integrated, i.e. capable of creating a comprehensive synergy including (hardware, software, features, and users), so that they cooperate within a single homogeneous system. Integration is a way that ensures consistency and harmony on different levels: business, informational, decision-making and technical.

- *Business level:* the bid is a business process focused on the operating results of the business processes. The company is not integrated at this level only if it manages to standardize and automate processes, so as to create coherence at the level of applications which feed the appropriate functions.
- *Informational level:* I.S must structure the knowledge and skills acquired during past bid experiences. The objective is that the enterprise can exchange and share its patrimony while contributing to new offers. The company is not integrated at this level, only if it manages to give a single, uniform image on its own capital of object that it manipulates in its functional scope and allows its reutilization from one action to another.
- *Decision-making level:* the company should regularly take strategic decisions to each evolutionary step of the bid project. Thus, its I.S must be able to optimize business decisions, while having the ability to predict the feasibility and profitability of the offer on the basis of its targeted objectives. The company is not qualified as expert at this level, only if it can decide easily on its own capital of object which it adapts from one action to another.
- *Technical level:* the applications needed to achieve a bid must cooperate in order to exchange the right information at the right time, which allows the user to take the right decision. This premise requires that the semantics undertaken by the exchanged data be interpreted in the same way by all enterprise applications.

Flexible: the company should survive in an unpredictable business environment: each bid process is realized in a specific context and consider specific solutions. That's why, I.S needs: on the one hand, to be able to overcome the market changes, from one offer to another (adaptability, scalability and extensibility) and on the other hand, to be able to react, on the right time, with the business agility (competitiveness and responsiveness). The company is considered flexible, when it manages to operate, adapt and easily extend its resources at different levels (business, informational, decision-making and technical) to fill and quickly meet the offers' terms during the different occasions of business that it accomplishes.

Interoperable: the company should not address offers and should not conduct business autonomously, and that's why I.S must be interoperable both inside, and outside its functional scope. Obviously, the interoperability is the fact that several systems can operate together while preserving their heterogeneity and autonomy. Thus, internal interoperability is a prerequisite to build an integrated I.S. On the other hand, given the competitive environment in which the business is involved, such a system must foster intercompany cooperation on the spot and in a dynamic way, whenever it is necessary to organize a partnership relation of a bid project, especially, during the construction of the techno-economic proposal: so it requires planning the dynamic interoperability at the external level. The enterprise is interoperable, unless its I.S is integrated internally and it manages to plan, to synchronize and to exchange: its trades, its data, its resources and its processes, easily with partners from the outer world, and this should happen despite their semantic differences.

2.2. Implantation of Bid Process Information System: "three fit" problems

We rely on the urbanization approach to establish an I.S dedicated to the exploitation of the bid process [8]. This approach is described according to four levels: (i) business view (it represents the company's operations and business processes that are necessary for the bid); (ii) functional view (it represents the functions and flow information towards business processes regardless of the technologies used); (iii) application view (to conceive all of the applications used by stakeholders to support functions and flows, and also to equip the process); and (iv) physical

view (it is the infrastructure on which are implemented and executed the application blocks to support the technical architecture). Nevertheless, this approach is facing the following problems (Fig. 1):

“*Vertical fit*” problem: the business and functional views describe the trades’ needs. They are abstract. But, the application and physical views represent definite implementations. However, the link’s difficulty or the “*vertical fit*” lies between an abstract ideal vision and a reality characterized by many problems including: integration, communication, updating, etc. It would be difficult to gather the data that allow scrutinizing the company’s operations. In fact, this results a fragmentary data in work system and reduces the efficiency of the company. These circumstances prevent from having a system which gives a complete and integrated image on company’s inner environment. Integrity, scalability, consistency and transposition are “*vertical fit*” issues that extends from a business infrastructure (logic) to a technical infrastructure (physical) in the company’s I.S.

“*Horizontal fit*” problem: it translates not only the applications’ problems of identification (induced by the “*vertical fit*” problems) that cover the entire infrastructure of the company’s business, but the intra-applicative communication problems (internal interoperability) to ensure the interactions between applications of the same technical infrastructure in the company (the same homogeneous system). Such failures make the global system disintegrated and little evolutionary.

“*Transversal fit*” problem: it translates the problems of inter-applicative communications (external interoperability carried out dynamically).

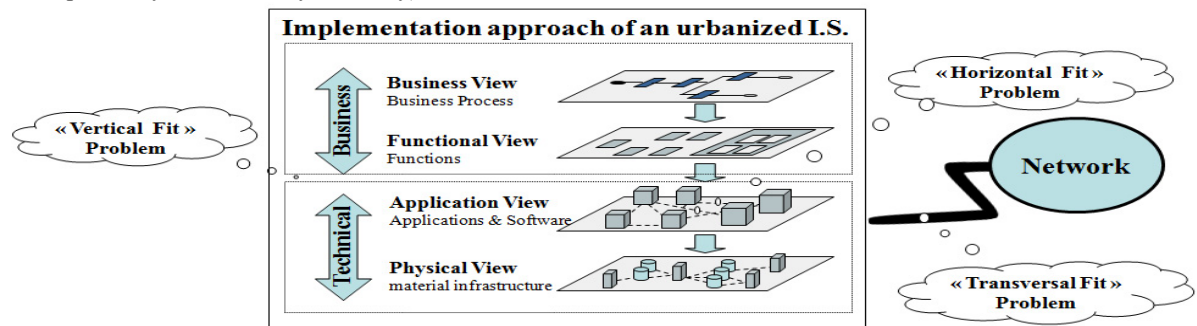


Fig. 1. Urban I.S reference model: problems of “three fit” [8].

To conclude, the “*three fit*” problems prevent the transversal exploitation of bid process, and as a consequence, it is difficult to have a unified bid vision. Solving such problems needs to meet the requirements associated with integrity, flexibility and interoperability on internal as well on external of I.S.

The internal interoperability concerns the applications within the same enterprise. But, the external must be dynamic, on demand, in order to realize a common goal within a virtual company. It should be noted that an I.S is flexible if it is: (i) extendable (relies on a technical architecture that promotes its branching); (ii) evolving (able to withstand a large amount of treatment without affecting its architecture); and (iii) adaptable (promotes reutilization which is based on the specification of I.S invariants). Thus, the flexibility qualification is easier to set up and realize if the I.S is integrated. However, an I.S is considered integrated only if: on the one hand, the coherence between all the applications is ensured (business and technical levels), and on the other hand, the uniqueness, relevance and reliability of information that feeds these applications is guaranteed (informational and decision-making levels). Still, this integrity assumption is valid only if intra-applicative communications are carried out without ambiguity. Henceforth, interoperability is a necessary condition for I.S to describe it as integrated. Finally, to get a flexible I.S, it must be integrated. However, this last feature is ensured if we solve the interoperability requirements. Indeed, this problem arises when I.S integration of the company (internal interoperability) is concerned as well as when a virtual company is organized (external or dynamic interoperability). However, the non-satisfaction of the interoperability requirement incurs significant costs associated primarily to time and resources which are presented to develop exchange information interfaces and knowledge sharing (technical interoperability), following a common semantics (semantic interoperability) and which are supposed to train actors and adapt organizational procedures

(organizational interoperability). Such assumptions influence negatively the overall performance of enterprises and more precisely the costs as well as the deadlines of getting the services expected while realizing a bid process.

3. Our Proposition : The Urbanized Bid Process Information System

Our main objective is to set up I.S which is integrated, flexible and interoperable and which allows a better exploitation of the bid process. Practically, we are interested, not only in implementing the right tools to achieve bid in one homogeneous system (integrated), but also, in solving the problems related to interactions intra, and even inter-applicative (interoperability). Our aim is to be able to exploit this system in different bids (flexibility). So far, we dealt with “three fit” problems. In this context, we suggest to meet these requirements by relying on four essential dimensions. They are: (i) the *operational dimension* that serves to specify the bid exploitation process by undertaking a specific project; (ii) the *organizational dimension* which allow to organize the set of skills and knowledge, that the company acquired during the previous bid in which it participated: the objective is a possible reutilization of this patrimony in future bid projects; (iii) the *decision-making dimension* which aims at optimizing and making the right decisions that concerns the market offers and that takes place during the company’s eventual participation in bid processes; and (iv) the *cooperative dimension* which aims at ensuring communication intra-enterprise (internal interoperability) and at planning the inter-enterprise communication on demand , in order to realize a common goal (dynamic interoperability). For example, while creating the offer’s technical proposal, one needs to organize inter-enterprise collaborations.

Afterwards, we treat respectively: *flexibility* through the *operational dimension*, *integrity* through the *organizational* as well as *decision-making dimensions*; and *interoperability* through the *cooperative dimension*. In fact, as far as the company is concerned, a flexible bid exploitation (*operational dimension*) requires an eventual integration at the level of I.S.; this fact targets reuse the best skills (*organizational dimension*) and adapt the best decisions (*decision-making dimension*), and learn from past bid experiences. All of this requires an internal interoperability within the participating company in the bid process to seek a homogeneous and coherent form of its I.S (*internal cooperative dimension*); and dynamic interoperability, at the level of a virtual company, built to realize in common a bid project, the fact that allows a better coordination and collaboration between various involved stakeholders (*dynamic collaborative dimension*). However, it is the operational dimension, which is deemed to be the main focus of our system, which acts and remains sensitive to variations in all other dimensions: the organizational and decision-making ones. These various dimensions are covered by the cooperative dimension itself.

Indeed, the *operational dimension* takes the *organizational dimension* as a basis in a specific bid. This premise is justified by the fact that the company reuses its own capital of objects for different actions, depending on its needs. This pushes the company create more and more products whose life cycle is shorter than those made in the past. This hypothesis is based on the re-design of existing products or creating similar design products, rather than, on producing new ones. In another way, the organizational dimension is based on the operational one, both while constructing a bid proposal, or after finishing it. In fact, the former (bid proposal in progress) comes to readjust the proposal, while the latter (bid proposal is finished), comes to update the company's capital through integrating the set of knowledge and skills built during this project. It is worthy to note that this assumption is beneficial for the company’s maturity, even when the company abandons its participation in the offer (the company closes its participation before the completion of the bid). In all cases, even if the owner chooses the proposals of other companies (the bid proposal is unsuccessful), a possible updating can take place and influence positively and beneficially, at least for future bids. If we follow the same logic, the *decision-making dimension* relies on the *operational dimension* and vice versa, which may or may not consolidate the company’s participation in the bid. It becomes evident that the *decision-making dimension* is inexorably related to the *organizational dimension*. All these dimensions are based on the *cooperative dimension*: on the one hand, the realization of the bid can be cooperative (*operational dimension* relies on the *cooperative dimension* for collaborative planning and for the creation of a complex product); and on the other hand, decisions can be cooperative (the *decision-making dimension* relies on the *cooperative dimension* for a *collaborative decision* during a definite bid).

We suggest exploiting these different dimensions, while relying on six main approaches, and by describing our urbanization approach of the I.S: The implementation of the Lean Manufacturing [12] approach allows designing a product perfectly adapted to the needs of its client and this product can be cheaper in costs but not less efficient than

its expected services. This approach integration adds value to the technical proposal construction which materializes a bid (Lean Manufacturing participates in solving the problem of “vertical fit”). The BPM (Business Process Management) incorporation [13] allows to model business and skill processes, particularly, the bid process. This approach facilitates the alignment of an integrated I.S with strategic directions, regardless technological constraints (BPM participates in the resolution of the problem of “vertical fit”). The KM (Knowledge Management) involvement [7] allows formalizing and modeling bid knowledge, whether explicit or implicit, in order to make them operational by the company during different bid projects that it realizes. This approach facilitates establishing a language and hence covers implementing the organizational dimension within the company (KM participates in solving the problem of “horizontal fit”). Furthermore, KM permits improving and responding to individual, collective and organizational learning acquired during a bid process. This hypothesis suits perfectly a bid context (KM takes part also in resolving the problem of “transversal fit”). The BI (Business Intelligence) integration [14] allows relying on methods, in order to provide decision-making assistance to those involved in a bid process. Therefore, this approach facilitates implementing explicitly the decision-making dimension within the company (BI participates in the problem resolution of “horizontal fit”). The SOA (Service-Oriented Architecture) [3] helps developing an easily flexible, extensible and adaptable I.S which can be materialized by a set of reusable application components. These application blocks communicate the practical implementation of “services” (clearly defined function in a way that makes it independent of the technical platform). The SOA facilitates the communications’ standardization, intra-applicative (SOA participates in the resolution of the problem of “horizontal fit”), as well as inter-applicative (SOA participates in solving the problem of “transversal fit”). In addition, SOA offers an innovative solution to manage the interface between the business needs and its technical implementation (SOA participates in the resolution of “vertical fit” problem). The company that takes part in a bid process needs to exploit its “services” at a distance, to promote collaborative work with its partners, such as the work constructed during the technical solution. The integration of Cloud Computing [9], allows the enterprise data and applications to be accessible and usable via the internet (Cloud Computing participates in the resolution of “transversal fit” problem).

Table 1. Bid Process I.S in the core of the coupling capacity of the six approaches.

		Flexibility		
		Integrity		Dynamic Interoperability
		Internal Interoperability		
		Vertical Fit	Horizontal Fit	Transversal Fit
Operational Dimension	Organizational Dimension	Lean Manufacturing / SOA/ BPM	KM	KM
	Decision-Making Dimension		BI	
	Cooperative Dimension		SOA	SOA / Cloud Computing

We can deduce that (Table 1): Lean Manufacturing, BPM and SOA allow us to overcome “vertical fit” problems and thus cover all the dimensions defined previously. KM, BI and SOA allow us to overcome “horizontal fit” problems as follows: KM permit to cover the *organizational dimension*, BI can cover the *decision-making dimension*, and SOA enable to cover the *cooperative dimension* at the level of the enterprise. In addition, SOA and Cloud Computing permit to overcome “transversal fit” problems and hence cover the *cooperative dimension* to the level of a virtual company. Also, KM participates in solving the “transversal fit” problems and consequently cover the *organizational* and *decision-making dimensions*. To this end, it is the *operational dimension* which can be supported by these six approaches. In other words, the satisfaction of this assumption enables us to have a *flexible, integrated, and interoperable*, I.S something that assures us a better exploitation of the bid process. We are particularly interested in solving the operational dimension’s requirements because it is the dynamo of all the other dimensions. For this reason, we suggest answering the following research question: *How can we make our I.S. flexible, open, and interoperable in order to optimize a specific bid process while starting from a context that fosters inter-company cooperation?* To answer this question, we will show that the ERP (Enterprise Resources Planning) [10] is the most suitable tool for the exploitation of a bid process, thus, it is a constructing support techno-economic solution of the offer (the ERP targets *operational dimension* of a bid). We will demonstrate that the ERP should be used at the heart of coupling the technological capacities and management (six approaches).

4. ERP inter-enterprises for the operational dimension of the bid process management

The ERP [10] aims to pilot the enterprise processes. In this framework, ERP producers suggest integrated packages based on the common skills between enterprises such as: financial, purchase and sales management, production management, technical data management (items, nomenclature, resources, manufacturing process), logistics management, etc. More precisely, these software producers build integrated application modules implementing the market's best practices for each function. Thus, the ERP is the most suitable for the complex processes exploitation within the enterprise, particularly; it helps to exploit the bid process. In fact, the bid process relies on the previously enumerated functions for its exploitation, notably; within the context of making the bid's techno-economic proposal (the ERP covers the bid's *operational dimension*). Nevertheless, there are primordial functions for the bid process evolution, but these functions are not treated by the ERP such as: expertise management (the ERP does not cover the *organizational dimension*), risk management and decision-making management (the ERP does not cover the *decision-making dimension*). This justifies our choice, in the previous paragraph which states to support the ERP by other tools in a way that enables treating a bid process. In fact, the ERP targets to meet the bid process *operational dimension*.

4.1. ERP: the support of the activity of product design

The operational dimension covers the activity of product design. This is an innovation activity, insofar as it involves human intellectual intervention. This requires a thorough knowledge of all the factors that are critical for a designer to create workable solutions, while respecting at best, constraints and objectives formalized in the specifications. This activity is subject to many and varied conditions (law domain, manufacturing constraints, functional requirements, etc.). In outlook to resolve the compatibility problems issues between the stakeholders involved in product design, we can rely to the ERP. In fact, the ERP permits to cover this activity. To do this, it is first to identify the list of links classifications, that is to say, specifying the relations (compound / components). The nomenclature describes the composition of a product manufactured (made) from its components, and the coefficients that indicate the amount of each component in each compound. Indeed, classifications are described level by level, thus corresponding to the stages of development of the product. Thus, we will obtain manufacturing trees whose root is the final product, and whose leaves are characterized by the purchased components and raw materials. Doing so allows us to simultaneously identify the list of components to buy and the list of components to be manufactured. For components to buy, it is a list of suppliers, and then chooses the suitable suppliers. For components to make, it is to identify ranges of manufacture: that is to say, the process of developing a product made from its direct components. Such processes are often represented by a set of steps or phases, and consume resources. Note that each component must be made (at least) a range of manufacturing, and many components can share the same range. Moreover, it is also to define the resources used by the different phases of the specified ranges. At the end of this work, the ERP allows us to define a Master Production Schedule.

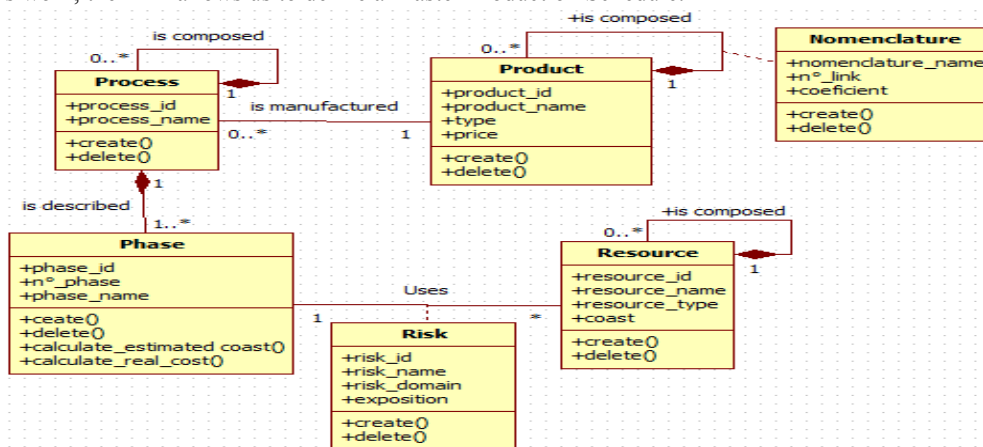


Fig. 2. Our knowledge capitalization model for the activity design of manufactured product.

Fig. 2 materializes our modelling relating to the knowledge capitalization of the design activity of manufactured products. The ERP ensures the exploitation of this model, so we can deduce that the ERP is a support for the design of manufactured products.

4.2. ERP: the heart of an industrial I.S. operational dimension

With the intention to manufacture valuable products to its customers, the manufacturing enterprise must plan the use of its resources (raw material, labor and machinery) while respecting the set of practices, rules, tools and methods. Such requirements represent the enterprise industrial culture. In other words, the company's skills and knowledge enable to ensure a good exploitation of its resources and more efficient production as expected by its clients. For this reason, the manufacturing factory is based on three tools' categories (piloting, support, and production). These tools meet the necessities of both customers as well as partners. We show that the ERP is at the heart of the industrial I.S., acting and remaining sensitive to variations of all the other tools making this system (the ERP is a piloting tool which supplies and provides the interface between support and production tools). We suggest describing the operational dimension which meets the requirements of an industrial I.S. by the following tools:

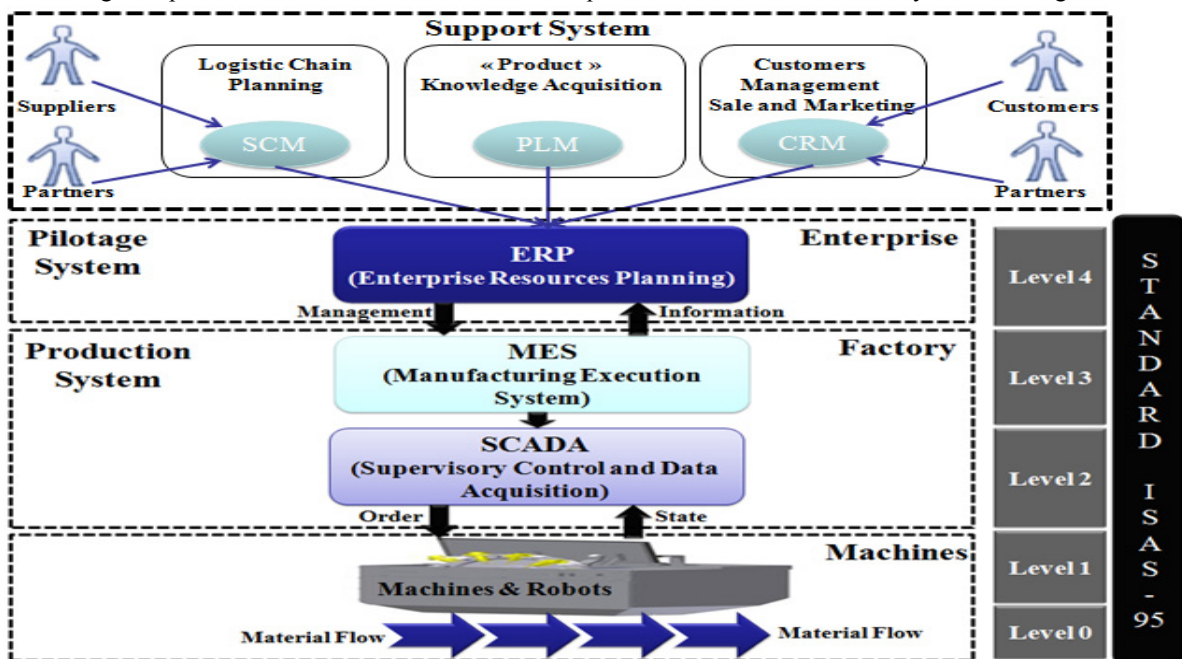


Fig. 3. Operational Dimension of an Industrial Information System.

CRM (Customer Relationship Management): is a system that manages customers' relationships, hence, it supports all the processes organizing the company's interactions with its customers (sale, marketing, and after sale services). In fact, while realizing a specific bid process project, the ERP disposes a module that allows managing the relationships with customers. However, it can rely on a CRM to check if the owner appears in his clients' list. This allows the company to view the history of its relationships with its customers in order to highlight their preferences. Such a strategy grants to increase the clients' loyalty and satisfaction, hence, it increases the enterprise chances to win the bid. In all cases, the CRM is a support tool that allows the company to have a set of coherent, reliable and accessible data for the client and as a result it delineates a better picture of their interactions.

PLM (Product Life-cycle Management): is a system that manages the technical data related to products' designing and manufacturing. It is noteworthy that the ERP is equipped by a module that aims to manage the technical data, and even to plan the product construction. As a result, in the case of a specific bid process, it can cover the realization of the technical proposal which makes the offer. However, the fact that the ERP relies on PLM

enables to reuse and adapt the processes and the existing equipment, and to visualize how they have been exploited in past projects. This strategy allows the company to operate its skills and technical abilities within a bid process project. This fact enables to optimize time and design costs of the technical proposal and to increase the chances of winning the bid. PLM is a support tool that can even maintain the coherence between the procedures used by different participating companies in the project: it facilitates the organization of data on the product.

SCM (Supply Chain Management): is the system responsible for the management of the enterprise logistic chain and its relationship with its partners (suppliers, distributors, subcontractors etc.). In fact, as soon as the client makes his order, the company and its employees start to find supply sources and seek to deliver the product or service on time, at lower cost according to the choice of the applicant and at a reasonable price. In this context, the SCM is a support tool that allows managing the physical flows of the company. In addition, it allows automating the movement of information flows beyond the borders of the company. More precisely, the SCM helps the company to create relationships with partners and spread its work in other companies. Note that the ERP has a module that allows planning the supply chain, in the context of a specific bid process. Once the offer is won, the SCM relies on ERP to follow and carry out, onsite, the plans done by the company and its partners.

MES (Manufacturing Execution System): is a system designed to obtain instantaneous supervision of a production workshop. It manages manufacturing orders coming from the ERP and sends back the state of outstanding amounts and a report on the events that occurred in the workshop. In fact, it is a tool supervising production and aiming to control the operation of the set of resources. It offers the company's users analysis indications on the equipment performance, as well as some pieces of information that describe the production status. Note that the MES allows actors, who are involved in the production, to work with a unique and homogeneous system even when they are from different departments of the same company.

The SCADA (Supervisory Control and Data Acquisition): is also a control system dedicated to production. Specifically, it intends to pilot and automate the production processes. In addition, this system favors the acquisition of monitoring data related to the execution of these processes environment. From an MES standpoint, the SCADA system constitutes a reinforcement to manage production.

We can deduce that SCM, CRM, and PLM are support tools, while MES and SCADA are production tools. Fig. 3 reveals that ERP is at the heart of the operational dimension of an industrial I.S. However, the enterprise that produces goods and services exploits these different business applications, without really integrating them, to follow the value chain. This causes consistency problems at the very heart of its I.S. it is also a constraint to manage flows, tasks, order and batch, etc and their corresponding information in real time. Actually, the main failure concerns intra-applicative information interactions and exchanges, especially between the piloting tool (ERP) and the producing ones (MES and SCADA). In fact, this limitation causes communication problems between business and manufacturing levels in the company which uses different software's (problems of terminology sharing between these different applications, which cause internal interoperability problems).

The norm ISA S-95 [2] suggests mitigating this limitation by defining terminologies and information models in order to establish a coherent communication between these two levels (Cf. Fig. 3). Thus, integrating these norms can establish coherence between: ERP which ensures a good management of resources; the MES which aims to achieve an effective supervision of the manufacturing system; the SCADA system which targets to optimize the supervision of processes and the acquisition of data. It is noteworthy that the MES is a bridge between the piloting system process and the organizational management level since it combines ERP and SCADA systems. In fact, the ISA S-95 standard intervenes in different levels (Cf. Fig. 3): (level 0) represents the current production processes; (level 1) defines the activities related to physical processes; (level 2) ensures the physical processes supervision and control; (level 3) defines the activity flow to manufacture finished products; and (level 4) defines the activities related to the company's business. These activities are necessary to manage the manufacturing organization.

4.3. ERP at the Heart of Coupling the Technological Capacities and Management

The success of implementing an ERP project dedicated to a particular enterprise must pass by design and platform coupling of reengineering and integration, internal versus external, trades and business processes. We are facing an exigency related to a specific governing strategy of each enterprise on each trade. This strategy intends to establish a simultaneous correspondence and alignment between two distinct objectives: the first refers to the ERP

agility (the ability to adapt to different management modes and to harmonize its exchanges with the appropriate partners). However, the second objective is linked to management processes, particularly, those exploited by a bid process (the enterprise's ability to innovate in an incremental and dynamic way opens the ground for a better management of costs, deadlines, risks, etc.). Our goal is to set up an ERP ad-hoc and its strategy as a solution. Therefore, the technical capacities and management coupling impose themselves. However, adaptability to the context or "conduit change" is a major factor of success for an ERP project throughout a functional integration. It is, on the one hand, a "governing affair" conduit which assures innovation in the management of business and trade processes. On the other hand, it is a "governing technology" conduit which ensures the dynamics of these processes. Besides, studies formalizing the combination between the two previously mentioned objectives are rare or non-existent. It is not easy to deploy a solution that aims to respond to such governance, combining an evolutionary and incremental approach to implement a technology that seeks the company's I.S. agility while allowing a better management of its business and trade processes. As a result, we rely on the NICT to answer this problematic. ERP has some limitations on management and technical levels. As a consequence, since the ERP relies on NICT, we are able to meet the limits detected on those two levels. This solution enables us a better management of the bid process.

It is true that the ERP aims to manage the bid process and its information flow. However, the fact that the ERP relies on a BPM approach, this allows to model the bid process and to subsequently align the ERP on strategic directions, without undergoing many technological constraints. Such a strategy helps the bid process standardization (this allows to have different ERP(s) with different layers of trade standards while realizing a bid process). Hence, the cooperation between enterprises and more accurately between ERP(s) (let us remember that an ERP covers a bid process operational dimension) is easier to realize, and in this way we get the impression that we are working on the same ERP (this solution is highly recommended during the collaborative construction of the offer's technical solution). Consequently, the BPM [14] will help us to construct an ERP in a modular way by assembling trade components weakly coupled. It remains only to solve the communication between different technical infrastructures which materialize the different ERP(s). We previously showed that the SOA [3] allows solving such problems.

The ERP enables to align processes best practices. However, it is unable to follow these good practices. Thus, the ERP does not adapt with the continuous improvement of the enterprise in its affairs. The fact that the ERP relies on Lean Manufacturing [12] strategy enables to overcome this limitation and helps the enterprise to establish a culture and a permanent maturity that revolves around good practices during the different contributions in different bid processes. The ERP does not permit reusing the enterprise's expertise acquired due to previous bid processes. As a result, the ERP must rely on an external system that enables to collect and to reconstitute the data and skills, in order to make them available, operational, and exploitable by an ERP during a specific bid process, in real-time. Therefore, the fact that the company relies on a KM approach and more accurately on an OM (Organizational Memory) [5], this enables the ERP to effectively exploit the enterprise's internal language in different bid processes. Note that, we suggested in [15] an OM sustained by an ontological framework in order to operate on certain business processes, we can accommodate this to realize a context for a bid process. The ERP is designed to collect the event traces, but it is not created to help the decision-making process. Consequently, the ERP inability to treat uncertainties and unexpected events limit its use to support the decision-making process in an environment of dynamic production. Therefore, the fact that the ERP is based on BI approach [14], and more precisely on a DW (Data Warehouse) [6], enables the enterprise's employees to get a rapid and synthetic access to strategic information. Furthermore, these employees can easily adapt their decisions taken in a past project to a specific bid process project.

We can deduce that a coupling between an ERP and management capacities (BPM, Lean Manufacturing, KM et BI) are highly recommended to meet the "governing affairs" level of a enterprise in a bid process project. Following the same logic, we demonstrate in what follows that a coupling between ERP architecture and technological capacities (SOA and Cloud Computing) is absolutely necessary to meet the "technological governing" level of the company in a bid process project. The structures provided by an SOA allow implementing ERP ad-hoc architecture in the enterprise hence helping it to surmount environmental turbulences, to respond to agility affairs quickly, and to improve the management of its markets and its bid processes [11]. Moreover, ERP solution based on SOA architecture helps to develop, at the very heart of the enterprise, new skills thanks to reutilization [3]. This strategy enables to enhance the company's expertise and to establish, as a consequence, a permanent culture of change. This is revealed to be necessary for the company's eventual adjustment in different contexts. These characteristics strongly favor the management by processes (this is strongly recommended to be able to manage and exploit the bid

process). In fact, the architectures suggested by SOA are flexible, adaptable reusable and extensible to a great extent. These architectures enable to easily integrate the new affairs costs realized by the enterprise in a specific bid process and to constantly develop trade and business processes modeling. Furthermore, the ERP deployed with SOA architecture ensures a low intra-applicative coupling (low coupling between ERP and the other applications used in the enterprise) as well as a low inter-applicative (low coupling between different ERP of different enterprises to realize a bid process). In certain cases, the ERP needs to exploit distant functions which are hosted externally. This requirement is realized if the enterprise includes Cloud Computing [9] approach during the implementation of its applications. Thus, the ERP must interact with applications of SaaS (Software as a Service) [4] mode each time it needs to exploit new functions which it does not cover. This solution is strongly recommended during the collaborative construction of a bid process proposal.

Finally, we validate the hypothesis that we departed from: *“the fact that the operational dimension ERP is based on six approaches (BPM, Lean Manufacturing, OM, BI, SOA and Cloud Computing), this helps us to meet other dimensions (organizational, decision-making and cooperative). Such solution allows us to have a flexible, integrated, and interoperable I.S., which helps us to ensure a better exploitation of the bid process.”*

5. Conclusion and perspectives

In this article, we presented our methodology of implementing a system of management for the exploitation of the bid process. Initially, we showed that such a system must be integrated, flexible and interoperable. However, during the implementation of this system, *“three fit”* problems fail the inclusion of such requirements. To overcome these deficiencies, we proposed to address the I.S design following four dimensions: the operational dimension (tackles flexibility), the organizational and decision-making dimension (tackles integrity) and the cooperative dimension (tackles interoperability). We are not only interested in implementing the right tools to achieve a bid process in one homogeneous system (integrated), but also, in solving problems related to interactions intra, or even inter-applicative (interoperability), which enable exploiting this system in different bids (flexibility). We showed that the ERP is the most suitable tool for the exploitation of a bid process, thus, it is a constructing support technoeconomic solution of the offer (the ERP targets *operational dimension* of a bid). We demonstrated that the ERP should be used at the heart of coupling the technological capacities and management (six approaches). Our work opens the horizon to exploit this suggestion within a concrete bid project.

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